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ORIGINAL RESEARCH

The state of emergency care in the Republic of the Sudan
L'état des soins d'urgence en République du Soudan

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Sudan is one of the largest African countries, covering an area of 1.9 million km^2—approximately one fifth of the geographic area of the United States. The population is 30 million people, the majority of whom (68%) live in rural areas, as compared with the sub-Saharan African average of approximately 62%. Sudan is considered a lower-middle income country—with 47% of the population living below the poverty line and a gross domestic product (GDP) of US $62 billion in 2010. In addition to excessive burden of communicable diseases such as malaria, tuberculosis, and schistosomiasis, Sudan is particularly susceptible to both natural and manmade disasters. Drought and flood are quite common due to Sudan's proximity to and dependency on the Nile, and throughout history Sudan has also been plagued with internal conflicts and outbreaks of violence, which bring about a burden of traumatic disease and demand high quality emergency care. The purpose of this paper is to describe the state of emergency care and Emergency Medicine education, and their context within the Sudanese health care system. As is the case in most African countries, emergency care is delivered by junior staff: new graduates from medical schools and unsupervised medical officers who handle all types of case presentations. In 2001, increased mortality and morbidity among unsorted patients prompted the Ministry of Health to introduce a new triage-based emergency care system. In late 2005, twenty-one Emergency physicians delivered these new Emergency Services. In 2011, following a curriculum workshop in November 2010, the Emergency Medicine residency program was started in Khartoum. Currently there are 27 rotating registrars, the first class of whom is expected to graduate in 2015.

Le Soudan est l'un des plus grands pays d'Afrique, avec une superficie d'1.9 million de km^2, soit environ un cinquième de la superficie des États-Unis. Le pays compte 30 millions d'habitants, dont la majeure partie (68%) vit en zone rurale, contre une moyenne de 62% en Afrique subsaharienne. Le Soudan est considéré comme un pays à revenu moyen inférieur, 47% de sa population vivant sous le seuil de pauvreté; le produit intérieur brut (PIB) du pays s'élevait à 62 milliards d'USD en 2010. Outre le fardeau excessif que constituent les maladies transmissibles telles que le paludisme, la tuberculose et la schistosomiase, le Soudan est particulièrement vulnérable aux catastrophes naturelles et d'origine humaine. Les sécheresses et les inondations sont relativement courantes en raison de la proximité et de la dépendance du Soudan au Nil; au cours de son histoire, le Soudan s'est également trouvé confronté à des conflits internes et des explosions de violence, avec les conséquences qui s'ensuivent en termes de maladies traumatiques et de besoin en soins d'urgence de grande qualité. L'objet de cet article est de décrire l'état des soins d'urgence et de l'enseignement en médecine d'urgence, ainsi que leur contexte au sein du système de santé soudanais. Comme dans la plupart des pays d'Afrique, les soins d'urgence sont dispensés par un personnel peu expérimenté: des médecins fraichement diplômés des écoles de médecine, et des médecins travaillant sans supervision prenant en charge tous types de cas se présentant. En 2001, la hausse de la mortalité et de la morbidité chez les patients non triés a incité le ministère de la Santé à introduire un nouveau système de soins d'urgence fondé sur le triage. Á la fin de l'année 2005, vingt-et-un médecins urgentistes ont dispensé ces nouveaux services d'urgence. En 2011, après un atelier de formation qui s'était déroulé en novembre 2010, le Program de résidence en médecine d'urgence a été lancé à Khartoum. Á l'heure actuelle, on dénombre 27 assistants chefs de clinique travaillant par roulement, dont la première promotion devrait être diplômée en 2015.

African relevance

- Cultural values contributed greatly to the various unique attributes of Sudan EM care.
- Federal hospitals such as Omdurman Teaching Hospital were the first nidus of EM care in Sudan.
- Weakness of integration between curative and preventive services leads to poor emergency services in the ground.
- Health coverage of the vast area of Sudan is a real challenge to politicians and health care workers.

Introduction

Situated in northeast Africa, Sudan is one of the largest countries on the continent, covering an area of 1.9 million km^2, approximately one fifth of the geographic area of the United States.[1] The 2010 census revealed a population of 43.6 million people, with a population density of approximately 17 persons/square kilometer.[1] The majority of the population (68%) lives in rural areas, as compared with the sub-Saharan African average of approximately 62%. With a gross domestic product (GDP) of US $62 billion in 2010, Sudan is considered

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a lower-middle income country—with 47% of the population living below the poverty line.[1] Khartoum, the capital of Sudan, gets its name from the Arabic meaning "end of an elephant's trunk." It was so named because of the strip of land between the White Nile River and the Blue Nile River. These two rivers meet in Khartoum to form the Nile River. The territory of the Republic of Sudan is divided into 17 states (Fig. 1).[2] As of July 9, 2011, the ten southern states form part of the independent nation of the Republic of South Sudan. In addition to excessive burden of communicable diseases such as malaria, tuberculosis, and cholera, Sudan is particularly susceptible to both natural and manmade disasters. Due to its proximity to and dependency on the Nile, drought and flood are quite common. Throughout history Sudan has been plagued with internal conflicts and outbreaks of violence, which bring about a burden of traumatic disease and a need for emergency care.

As a country, Sudan is very diverse—with hundreds of languages, ethnicities, and tribal divisions. Most of the urban centers lie within the northern states. In this region, Arabic-speaking Muslims comprise the majority of people, although many people also speak traditional non-Arabic mother tongues. The population of Khartoum is growing rapidly, currently exceeding six million,[2] including internally displaced persons (IDPs) from several areas in Sudan. The majority of IDPs migrate, seeking better employment and educational opportunities.

Sudan is frequently impacted by natural disasters including drought, heavy rains, and floods. The epidemiological profile of the country is typical of Sub-Saharan African countries: communicable diseases and malnutrition dominate the burden of disease, and there is high vulnerability to outbreaks. Emerging and re-emerging diseases are also present; many of these illnesses are compounded by factors beyond the health care system. The primary causes of mortality are infectious and parasitic diseases: TB, malaria, schistosomiasis, diarrheal diseases, respiratory infections, and protein-energy malnutrition (Table 1).[3]

Due to changing socio-economic and lifestyle conditions, non-communicable diseases are emerging as a public health problem worldwide. Diseases, such as diabetes, hypertension, and ischemic heart disease are emerging with new dimensions (Table 2).[3] Currently they are responsible for 19.2% of the country's annual mortality.[3,4] Communicable diseases are also increasing as causes for hospital admission (Table 2).[3]

Structure of health care system in Sudan

In Sudan, primary health care facilities include primary health care units (PHCU), dressing stations (DS), dispensaries, health centers and rural hospitals (Table 3).

The Basic Health Unit (BHU) is the smallest health facility delivering primary health care. BHUs are staffed by community health workers (CHWs), while dressing stations (DS) are staffed by a nurse or a medical assistant, and dispensaries are headed by a medical assistant. According to the Federal Ministry of Health (FMoH) Facility Description and Renaming Policy, the minimum acceptable facility level for health services provision is now the Basic Health Unit.

Figure 1 Map of Sudan. *Source:* http://www.mapsopensource.com.

Table 1 Top 10 causes of mortality and morbidity in Sudan, 2010.[5]

	Mortality	%[a]	Morbidity	%[b]
1	Septicaemia	7.0	Malaria	12
2	Pneumonia	5.5	Respiratory tract infection	8
3	Other heart diseases	5.2	Pneumonia	8
4	Circulatory system	5.0	Diarrhea and gastroenteritis	5
5	Malaria	4.4	Acute tonsillitis	4
6	Heart failure	4.1	Urinary tract disorders	4
7	Renal failure	4.1	Hypertension	3
8	Malignant neoplasm	3.9	Injuries and wound	3
9	Malnutrition	3.7	Diabetes mellitus	3
10	Diabetes mellitus	2.6	Disorder of eye	2

[a] Percentage of total deaths.
[b] Percentage of total cases.

Table 2 Non-communicable diseases in North Sudan: prevalence and percent cause of admission, 2010.[6]

Disease	Prevalence (%)	Cause of admission (%)
Hypertension	3.1	1.7
Trauma and Minor injuries	3	NR
Diabetes	2.5	2.2
Asthma	1.3	3.1
Cancer	0.3	0.6
Heart disease	NR	2.2

NR, not reported.

Staffed by a physician, rural health centers and urban health centers are the primary referral level for the BHUs in rural and urban localities, respectively. Rural health centers serve up to 20,000 people, and urban health centers will serve up to 50,000 people. Lower level PHC health facilities (BHUs and Health Centres) are managed and financed by the localities.

Rural hospitals are the secondary referral level for lower level health facilities and serve 100,000–250,000 people in the locality. Each rural hospital is expected to have 40–100 beds and is managed and financed by the State Ministry of Health (SMoH).

Tertiary hospitals, including teaching hospitals and specialized hospitals, are located in state capitals and are operated by the SMoHs. They provide different levels of care including emergency services, inpatient and outpatients services in all disciplines. They are the training hospitals for both undergraduate and postgraduate students. In addition, the ksMoH (Khartoum State Ministry of health) operates 21 tertiary care hospitals and specialized centers. ksMoH hospitals also offer ICU services. The specialized centers include GI bleeding, Neurology, Nephrology, Cardiac, Respiratory, Dentistry, ENT, Ophthalmology, Maternity, and Pediatrics. Advanced diagnostic and therapeutic services are provided at these institutions.

Access to care

The interim Constitution of Sudan states that free primary health care and emergency services can be provided for all citizens: "The state shall promote public health, establish, rehabilitate and develop basic medical and diagnostic institutions and provide free primary health care and emergency services for all citizens".[7] The primary health care package includes, at a minimum:

- *Promotion of child health:* This includes immunization against vaccine-preventable diseases, nutrition counseling, growth-monitoring, and implementation of the Integrated Management of Childhood Illness (IMCI) package.
- Promotion of school health.
- *Promotion of reproductive health:* This includes safe motherhood, safe pregnancy, and family planning.
- Control of endemic diseases, such as malaria, tuberculosis, HIV/AIDS, and schistosomiasis.
- Promotion of environmental health and sanitation.
- Treatment of injuries, diseases, and mental illness.

Prolonged conflict in Sudan has disrupted the health system; much of the infrastructure has either been destroyed or

Table 3 Structure of the health care system in Sudan.

	Head staff	Remarks
Primary health care level		
Primary health care unit (PHCU)*	Community health workers (CHWs)	*These will be replaced by the basic health unit (BHU)
Dressing stations (DS)*	Nurse	
Dispensaries*	Medical assistant	
Basic health unit (BHU)	Medical assistant	
First referral level (health centers)		
Rural	Doctor	Serve 20,000 people in rural areas
Urban health centers	Doctor	Serve 50,000 people in urban areas
Rural hospital	Doctors including specialist	100,000–250,000 people in the locality

need to be repaired. As a result of the use of dilapidated buildings and a lack of necessary equipment, many health facilities are not currently functional. This situation also applies to various programs as well. The referral system between the different levels is still rudimentary.

Despite governmental requirements, overall basic health service coverage is low. There are also significant urban, rural, and regional disparities in the availability of health resources and services. Many of the health facilities either do not function or do not satisfy minimum requirements. In the North, the current health facility population ratios of one rural hospital for every 100,000 population and one health center for every 34,000 of the population are below acceptable levels.[8] The number of health facilities providing primary health care services should be one facility per 5000 population but it is far below that ratio.[8] Furthermore, the existing lower health facilities (dressing stations and PHCU) need to be upgraded to BHUs. The health care system is distinctly skewed toward inpatient and tertiary care services.

The role of the private sector in providing health services is not well documented. Private health services are concentrated in urban settings and better-off states, focus on curative services, and provide very few preventive interventions, immunizations, or health promotion activities.[8] Private health facilities currently possess 17% of bed capacity, 36% of X-ray units, 54% of ultrasound units, 80% of CT scanners and 95% of MRI units in the Khartoum state.[8]

The systems and regulations governing the private sector are poorly enforced. Issues and challenges include quality assurance, competition policies, price moderation, regulation and public–private partnership. Public employees are allowed to practice in the private sector in their leisure time, however this policy is abused by many of the workers: many of them work in the private sector during official business hours.

Emergency care

Hospital-based

The number of health care facilities in Sudan is increasing every year. As of 2010, there are 5097 functioning basic health care units across the country.[2] However as the number of annual admissions is increasing, the number of beds per 100,000 people is decreasing.

Emergency medical services (EMS)-based

Until 2005 there was no EMS system in Sudan. Furthermore the newly developed service is lacking organization, trained personnel and adequate equipment.[9] EMS providers currently provide transportation to the hospital but are not formally educated in basic or advanced life support. Patients often arrive in ''toc–tocs'' instead because they are much cheaper and often arrive at their destination much more quickly.

Unique attributes to EM in Sudan

There are many cultural and legal differences observed in the Sudanese Emergency Medicine. A few notable variations include:

- One needs to obtain consent from a patient or her family to send a pregnancy test. This truth may be in part due to the fact that abortion is strictly illegal.
- CPR is refused by some relatives who think that their relatives' dead bodies are humiliated by crushing their chests.
- Some tribes think that donating blood causes sterility in males and hence refuse donation especially if for their wives.
- Post-mortem studies are refused by majority of our population, and can only be done if crime is suspected.
- Hair dye poisoning is the preferred method of suicide. This leads to an increased incidence of acute renal failure if the suicide attempt is unsuccessful.
- Brain death and organ donation laws are still under the legalization process. No attempt of extubation can be made unless there is full agreement and consent of the family. As the old law is still in effect, these physicians would be considered murderers if they did not abide.

In addition to these cultural and legal differences, the structure of health care reimbursement and financial coverage is also unique in Sudan. From the colonial period until the beginning of 1990, health services were offered free of charge. In the early 1990s user fees were introduced as part of the economic sector reform. However, to ameliorate the negative impact of the introduction of user fees on accessing health services, emergency care is exempt from user fees.

Emergency Medicine education in Sudan

Many patients present directly to large (now ksMoH) hospitals such as the Khartoum Teaching Hospital, Khartoum North Teaching Hospital, and Omdurman Teaching Hospital. The principal reason behind this accumulation is the poor or non-existent medical care at the primary and secondary care levels.[10] At the large (now ksMoH) hospitals, a mixture of emergency and non-emergency cases waits to receive similar services. This waiting often harms patients with life-threatening conditions and leads to the loss of their right to receive free treatment.

In 2001, triage-based emergency care was introduced by the Federal Ministry of Health into the three largest hospitals in the country (Khartoum Teaching Hospital, Khartoum North Teaching Hospital, and Omdurman Teaching Hospital), as a possible solution to the increased morbidity and mortality observed in non-triaged patients. In the former system, both urgent and non-urgent patients were seen directly by the very junior doctors (house-officers) together in the same clinic. With the new triage-based system, patients are initially assessed by a nurse who performs primary triage and then transfers them to the appropriate different levels of care.

Since then, there have been other difficulties in the delivery of emergency care: There is a need for an Emergency Specialist 24/7 in the ED, however at the moment house-officers and registrars are the main physicians caring for these critical patients. In addition, the Emergency Department has poor infrastructure and is thus unequipped to deal with disasters and other times when surge capacity is necessary.

Nursing staff and other ancillary providers are also still catching up in numbers. In 2001, 5 senior nurses were sent to Malaysia to be formally trained in the Malaysian Triage System.[11] In 2007, three Emergency Medicine medical officers

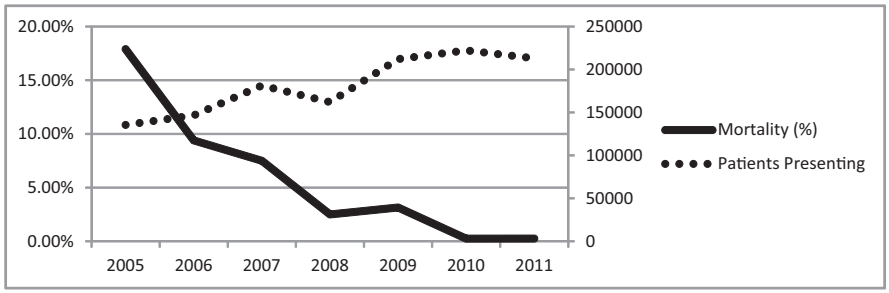

Figure 2 Number of patients (and mortality) presenting to Omdurman Accident and Emergency Hospital.[13]

were selected from the three hospitals and sent to Malaysia to obtain their MD in Emergency Medicine. Over the years their numbers have increased, and are now approaching 15 current trainees.

In 2002, the Khartoum North Hospital developed the first model for emergency care in Sudan. The system works on the basis of sorting and classification of patients (triage) to emergency situations with one of 3 classifications: special care, urgent care, and non-emergency care. Physicians in separate public clinics deal with non-emergency cases.

In 2005, basic adjustments in the infrastructure of both Omdurman and Khartoum Hospitals were made to start the new triage-based Emergency Departments. Dedicated full-time emergency specialists were appointed, in addition to the ongoing training for new ED medical officers and nurses in the system. A set of cadres were created for the first time in the health system, such as porters, patient service officers, and officers for the care of homeless patients. The basic areas in the System were the triage area, resuscitation area, an area for critical ill patients, an area for less severe cases, and a room for all traumatic patients. Non-urgent cases are assessed in a separate area.

Built in 1898, the Omdurman Teaching Hospital is a large hospital serving a population of more than 4,000,000. After implementing the new system, Omdurman observed the high admission rates, with a corresponding decrease in mortality over the years (Fig. 2).

The Sudanese Federal Ministry of Health and the Ministry of Human Resources and Labor recognized the need for the Emergency Medicine as a subspeciality. The Sudan Medical Specialization Board[12]—responsible for almost all post-graduate trainings in Sudan—as well as members from other specialities and Internal-Medicine trained Sudanese Emergency Physicians working in Sudan and other countries came together to create the EM board.

The Emergency Medicine residency program was established in 2011, following a Curriculum Workshop in November 2010. Currently the first class of EM residents is in their second year of training. The program will consist of 2 years of EM training in Sudan, and then 2 years at an international destination that is to be determined. Omdurman training center is currently training 8 Emergency Medicine residents. Omdurman is unique in another way: the Emergency Department has an electronic record, while the rest of the hospital still has paper records. The government pays for most routine lab work; results usually return in less than two hours.

Omdurman ED is unique in other ways as well. It is the first hospital in Sudan to have a disaster plan which was tested by the first national drill in 2009 and by the following real disasters: the Khalil terroristic attack in 2010, and the Egypt and Algeria football match. It was also the referral center for victims of methanol intoxication and chlorine poisoning.

Specific areas for improvement

Currently there is no formal triage system. Medicine is taught in English—this makes it a perfect opportunity for international collaboration. Potential barriers include tight restrictions from the Sudanese government for foreigners to work in their country.

Improving training by exchange programs will have great impact on the quality of service delivered. Investment in the training of emergency nurses will change the delivery of service upside down.

Establishment of undergraduate Emergency Medicine curriculum will broaden the concept of Emergency Medicine and will attract young generation to be involved in the field.

There is great effort spent on the preparedness phase for emergencies by the FMoH, but weakness of integration between curative and preventive services leads them to work in isolation, which results in poor emergency services on the ground.

Conclusions

Sudan occupies nearly 2% of the earth's surface, however the country finds great difficulty securing an acceptable level of health services. The expenditure on health is least compared to the massive amount spent on defense. Emergency services are not an exception. Establishing a good emergency health service is a big challenge to both decision-makers and health professionals. Obstacles to establish strong emergency services in Sudan include lack of financial support, lack of specialist physicians and technicians, negative views of old-fashioned physicians, and a persistent absence of Emergency Medicine from medical school curricula. While communicable diseases were the predominant causes of morbidity and mortality in the last decade, non-communicable diseases and injury have taken the lead. The need for high quality emergency services is evident, and actions have been taken toward improvement.

Khartoum state is unique in having the old emergency system based on non-trained house-officers as front-liners are slowly replaced by a resident 24-h emergency specialist; other

Sudan states are lagging behind. Fortunately with the establishment of an emergency residency program, they hope to graduate the first class of emergency-medicine-trained specialists in 2015. With recession, the overall economy is poor; with the cessation of South Sudan petrol export, many well-trained medical officers and outside trained emergency specialists are brain-drained to the nearby rich Gulf countries for better quality of life and job satisfaction.

An enormous effort is needed by all the concerned sectors (the government, professionals, organizations of civil society, and international donors) to initiate and maintain high quality emergency health services for all of Sudan.

Conflicts of interest

The authors declare no conflict of interest.

Author contribution

Both authors N.R. and G.A.J. wrote the text of the manuscript. G.A.J. formatted it and prepared it for submission.

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